

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claim 1 (Currently Amended): A magnetic head provided with a spin-valve type magnetoresistive element in which a ferromagnetic layer a direction of the magnetization of which is substantially pinned for an external magnetic field and a soft magnetic free layer the magnetization of which can be turned according to an external magnetic field₁ are laminated₁ via a non-magnetic intermediate layer₁ and characterized in that the magnetization of the soft magnetic free layer is rotated according to the external magnetic field₁ ~~is induced~~, a relative angle between a direction of the magnetization of the soft magnetic layer and a direction of the magnetization of the ferromagnetic layer varies and magnetoresistance is produced, wherein:

a single magnetic domain turning ferromagnetic layer¹⁰ is formed on the soft magnetic free layer₁ via a non-magnetic separating layer; and

the single magnetic domain turning ferromagnetic layer turns the soft magnetic free layer a single magnetic domain so that the soft magnetic free layer has magnetization substantially induced in a direction substantially perpendicular to an external magnetic field because the soft magnetic free layer and the single magnetic domain turning ferromagnetic layer are magnetostatically coupled₁ via the non-magnetic separating layer₁ at the end of track width₁ and a closed magnetic circuit is formed; and

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the single magnetic domain turning ferromagnetic layer has effectively fixed magnetization in the direction of substantially perpendicular to an external magnetic field from a magnetic medium.

Allow

Claim 2 (Currently Amended):

A magnetic head, comprising:

A
a spin-valve type magnetoresistive element in which a ferromagnetic pinned layer, a non-magnetic intermediate layer, a soft magnetic free layer, a non-magnetic separating layer and a single magnetic domain turning ferromagnetic layer are laminated in the order and are formed in substantially the same track width corresponding to a predetermined magnetic field sensing width, wherein:

no ferromagnetic or antiferromagnetic coupling is substantially produced between the soft magnetic free layer and the single magnetic domain turning ferromagnetic layer, via the non-magnetic separating layer, the magnetization of the single magnetic domain turning ferromagnetic layer and the magnetization of the soft magnetic free layer are magnetostatically coupled at the end of track width, and a closed magnetic circuit is formed;

the soft magnetic free layer is turned a single magnetic domain so that the soft magnetic free layer has magnetization substantially induced in a direction substantially perpendicular to an external magnetic field; ~~and~~

a direction of the magnetization of the ferromagnetic induced layer is substantially pinned for an external magnetic field, the magnetization of the soft magnetic free layer is turned according to an external magnetic field, a relative angle between the magnetization of the soft magnetic free layer and the magnetization of

the ferromagnetic pinned layer varies, magnetoresistive change is generated in the magnetoresistive element and is detected by a pair of electrodes; and

the single magnetic domain turning ferromagnetic layer has effectively fixed magnetization in the direction of substantially perpendicular to an external magnetic field from a magnetic medium.

Claim 3 (Original): A magnetic head according to Claim 1, wherein:
a bias magnetic field is applied to the ferromagnetic pinned layer by laminating the ferromagnetic pinned layer and an antiferromagnetic film or a hard magnetic film and producing exchange coupling and the ferromagnetic pinned layer is polarized in a direction substantially perpendicular to an external magnetic field.

Claim 4 (Original): A magnetic head according to Claim 1, wherein:
the single magnetic domain turning ferromagnetic layer is formed by a hard magnetic film; and
the hard magnetic film is magnetizing in a direction substantially perpendicular to an external magnetic field.

Claim 5 (Original): A magnetic head according to Claim 1, wherein:
the single magnetic domain turning ferromagnetic layer is formed by a layered film having ferromagnetic or antiferromagnetic coupling between a hard magnetic film and a soft magnetic buffer layer via a coupling film; and

the magnetization of the hard magnetic film and the magnetization of the soft magnetic buffer layer are polarized in a direction substantially perpendicular to an external magnetic field.

Claim 6 (Original): A magnetic head according to Claim 1, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of oxide including Fe, Co, Ni or Mn.

Claim 7 (Original): A magnetic head according to Claim 1, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of a mixture of oxide and ferromagnetic metal.

Claim 8 (Original): A magnetic head according to Claim 1, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of a mixture of a semiconductor and ferromagnetic metal.

Claim 9 (Original): A magnetic head according to Claim 1, wherein:
the non-magnetic separating layer is made of Ta, Hf, Nb, Ti or W or the oxide of any of these.

Claim 10 (Original): A magnetic head according to Claim 1,
wherein:

the non-magnetic separating layer is formed by a deposition of a layer including at least one of Cu, Au, Ag, Pt, Re, Ru, Ir, Os, Ta, Hf, Nb, Ti and W or a

layer including these and a layer made of oxide or a mixture of at least one of Cu, Au, Ag, Pt, Re, Ru, Ir, Os, Ta, Hf, Nb, Ti and W and oxide.

Claim 11 (New): A magnetic head according to Claim 2, wherein:

the single magnetic domain turning ferromagnetic layer is formed by a hard magnetic film; and

the hard magnetic film is magnetizing in a direction substantially perpendicular to an external magnetic field.

Claim 12 (New): A magnetic head according to Claim 2, wherein:

the single magnetic domain turning ferromagnetic layer is formed by a layered film having ferromagnetic or antiferromagnetic coupling between a hard magnetic film and a soft magnetic buffer layer, via a coupling film; and

the magnetization of the hard magnetic film and the magnetization of the soft magnetic buffer layer are polarized in a direction substantially perpendicular to an external magnetic field.


Claim 13 (New): A magnetic head according to Claim 2, wherein:

the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of oxide including Fe, Co, Ni or Mn.

Claim 14 (New): A magnetic head according to Claim 2, wherein:

the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of a mixture of oxide and ferromagnetic metal.

Claim 15 (New): A magnetic head according to Claim 2, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a
hard magnetic film made of a mixture of a semiconductor and ferromagnetic metal.

 **Claim 16 (New):** A magnetic head comprising:
a magnetoresistive element having a soft magnetic free layer, a ferromagnetic
pinned layer and a non-magnetic layer formed between the soft magnetic free layer
and the ferromagnetic pinned layer,
a single magnetic domain turning ferromagnetic layer having effectively fixed
magnetization in the direction of substantially perpendicular to an external magnetic
field from a magnetic medium, formed above the soft magnetic free layer,
wherein a magnetization of the single magnetic domain turning ferromagnetic
layer and a magnetization of the magnetic free layer are magnetostatically coupled
at the end of track width.

Claim 17 (New): A magnetic head according to claim 16, wherein
the total magnetization of the single magnetic domain turning ferromagnetic layer
and the magnetic free layer forms a closed magnetic circuit.

Claim 18 (New): A magnetic head according to claim 16, wherein a
non-magnetic separating layer is formed between the single, magnetic domain
turning ferromagnetic layer and the soft magnetic free layer.

Claim 19 (New): A magnetic head according to claim 16, wherein the single magnetic domain turning ferromagnetic layer turns the soft magnetic free layer a single magnetic domain so that the soft magnetic free layer has magnetization substantially induced in a direction substantially perpendicular to an external magnetic field.


Claim 20 (New): A magnetic head according to Claim 16, wherein:
a bias magnetic field is applied to the ferromagnetic pinned layer by laminating the ferromagnetic pinned layer and an antiferromagnetic film or a hard magnetic film and producing exchange coupling and the ferromagnetic pinned layer is polarized in a direction substantially perpendicular to an external magnetic field.

Claim 21 (New): A magnetic head according to Claim 16, wherein:
the single magnetic domain turning ferromagnetic layer is formed by a hard magnetic film; and
the hard magnetic film is magnetizing in a direction substantially perpendicular to an external magnetic field.

Claim 22 (New): A magnetic head according to Claim 17, wherein:
the single magnetic domain turning ferromagnetic layer is formed by a layered film having ferromagnetic or antiferromagnetic coupling between a hard magnetic film and a soft magnetic buffer layer, via a coupling film; and

the magnetization of the hard magnetic film and the magnetization of the soft magnetic buffer layer are polarized in a direction substantially perpendicular to an external magnetic field.

Claim 23 (New): A magnetic head according to Claim 16, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of oxide including Fe, Co, Ni or Mn.

**Claim 24 (New):** A magnetic head according to Claim 16, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of a mixture of oxide and ferromagnetic metal.

Claim 25 (New): A magnetic head according to Claim 16, wherein:
the single magnetic domain turning ferromagnetic layer is provided with a hard magnetic film made of a mixture of a semiconductor and ferromagnetic metal.

Claim 26 (New): A magnetic head according to Claim 16, wherein:
the non-magnetic separating layer is made of Ta, Hf, Nb, Ti or W or the oxide of any of these.

Claim 27 (New): A magnetic head according to Claim 16, wherein:
the non-magnetic separating layer is formed by a deposition of a layer including at least one of Cu, Au, Ag, Pt, Re, Ru, Ir, Os, Ta, Hf, Nb, Ti and W or a

layer including these and a layer made of oxide or a mixture of at least one of Cu, Au, Ag, Pt, Re, Ru, Ir, Os, Ta, Hf, Nb, Ti and W and oxide.
